Module 6. The Erosion and Sediment Control Planning Process

Module 6 Objectives

After completing this module, you will be able to:

- Understand the planning needed to develop an erosion and sediment control plan
- Identify the two parts of an Erosion and Sediment Control Plan
- Recognize vegetative control practices and how and where to apply them
- Recognize structural control practices and how and where to apply them

Module content

6a. Introduction

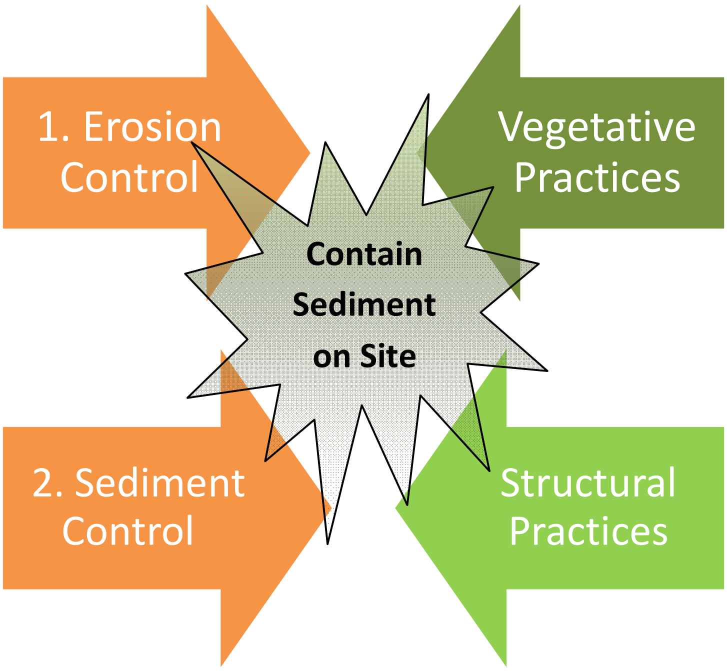
We now know why we need to conduct erosion and sediment control:

- Law
- Regulations
- Environmental stewardship/responsibility

If there is no erosion there is no sediment

We have seen that:

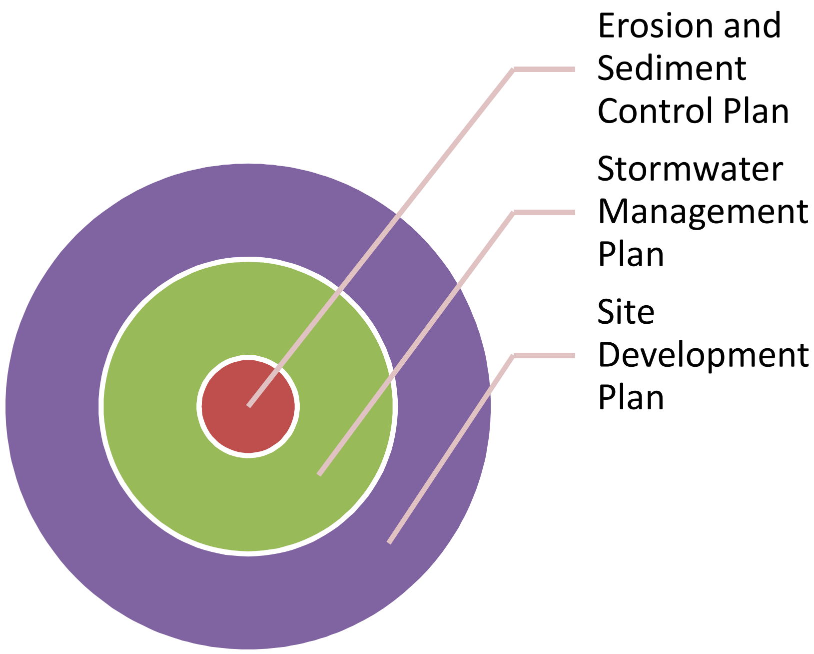
- Erosion Control is the first line of defense
- Sediment Control is the second line of defense



Sediment control practices are typically 60% efficient. **Thus, proper and careful Erosion and sediment Control Planning is essential.**

6b. Comprehensive Site Planning

Erosion and sediment control planning should be an integral part of site planning and not an afterthought. An ESC Plan should be part of an entire development plan that may include: detailed drawings, architectural details, framing details, traffic studies, and stormwater considerations. (Note: this is not a detailed list containing all submittals; however, it should be a standalone plan for use in the field.)



An erosion and sediment control plan should be stand-alone component of the entire site development plan

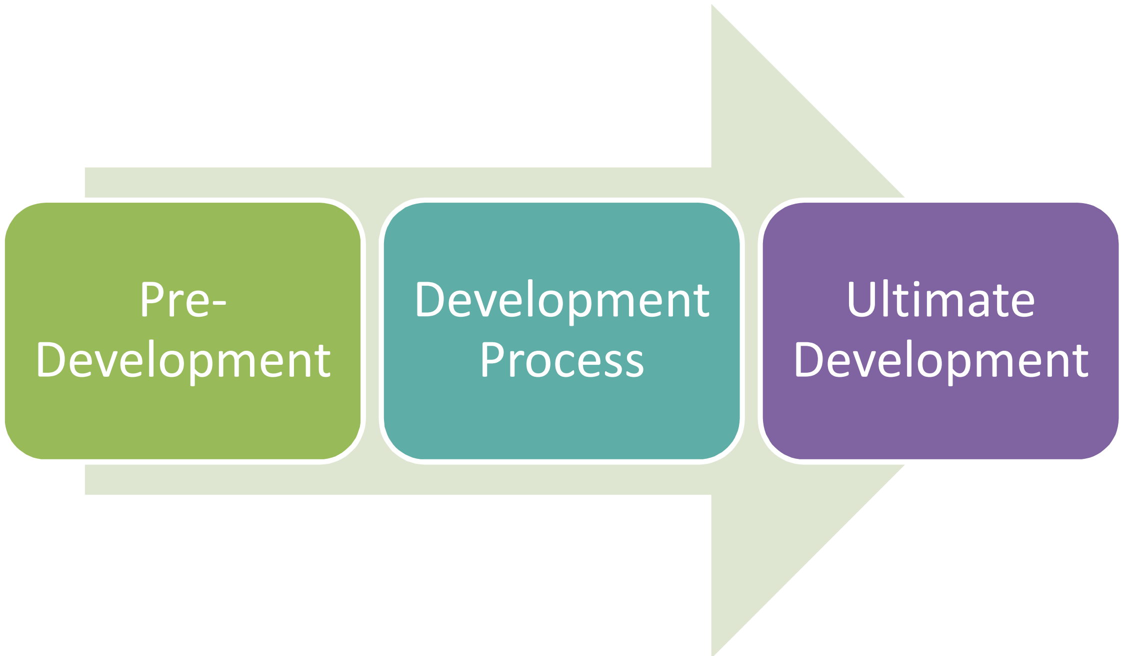
Planning process

While planning for erosion and sediment control is often an independent process, it is also often part of the entire site design process. Many of the questions addressed in ESC planning are not unique to this part of a project and should not be considered in isolation. Moreover, they may be answered during the development of the other parts of the site planning process as well.

In developing an ESC plan we need to consider a number of things:

a. What is the current status of the property;
b. How about the surrounding properties, in particular those down gradient;
c. What is the ultimate development condition;
d. What is the development or construction sequence;
e. Where are the potential erosion and sedimentation hot spots;
f. Practices to prevent erosion on site and sediment from leaving the site;
g. Stormwater runoff considerations; and
h. Maintenance during and post construction.

In other words the careful planning of a site being developed is important. Chapter 6 of the Erosion and Sediment Control Handbook details the preparation of an Erosion and Sediment Control Plan.



When planning erosion and sediment control we need to bring the site from the predevelopment state all the way through to the ultimate development state.

a. Predevelopment Conditions

Knowing where the proposed development site is located and what existing conditions are crucial in the development of a site. We need to know:

- The sites geographic location. Virginia is a very diverse state (see figures 1and 2 below). All the regions indicated on that map have differences in climate (temperature and precipitations), topography, slopes, drainage patterns, geology, soils, and vegetation.

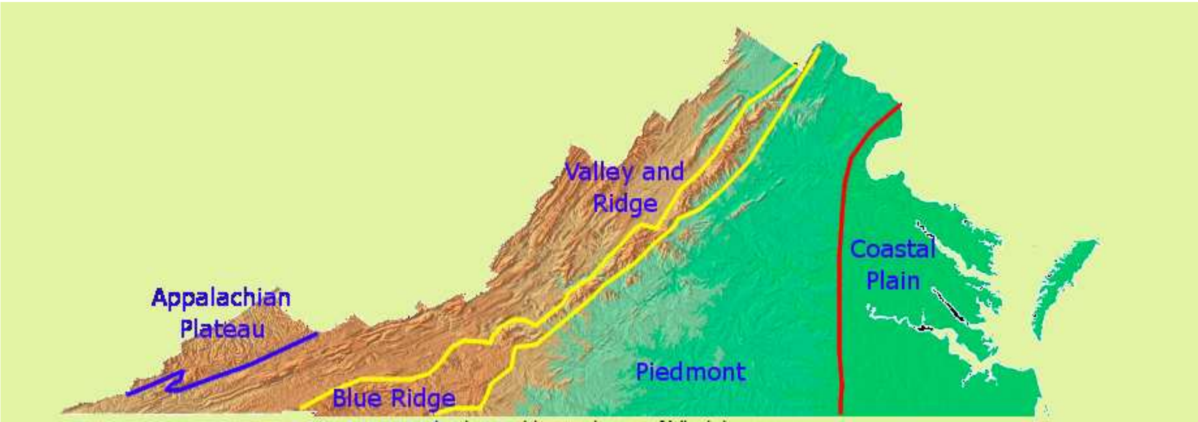


Figure 1. The physiographic provinces of Virginia

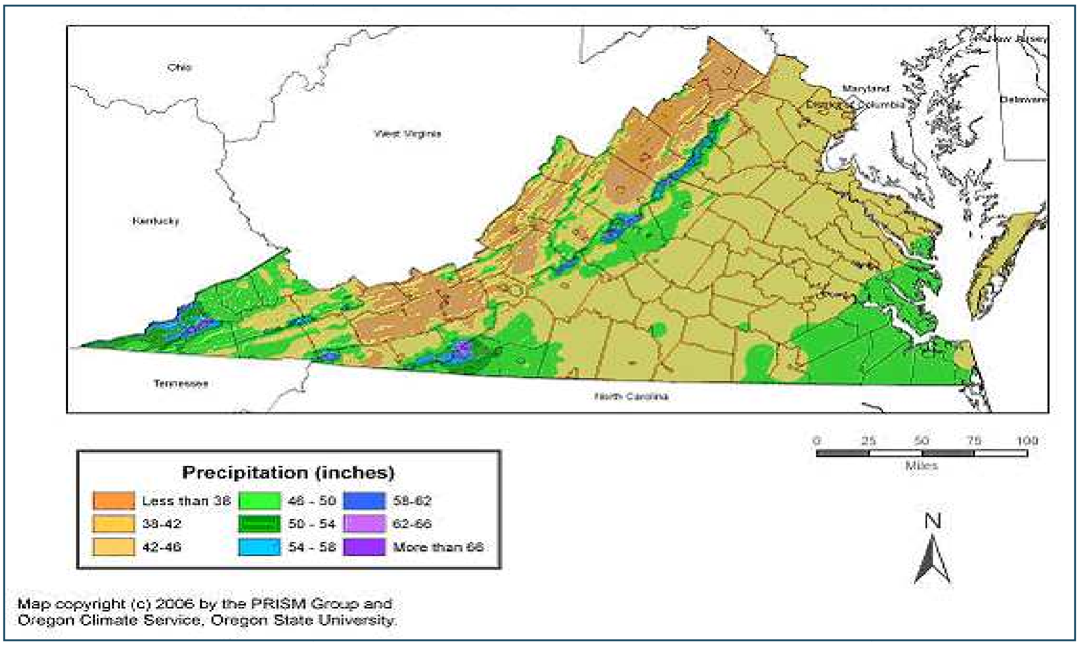


Figure 2. Average Virginia Annual Precipitation, 1970-2000. (Source: Oregon Climate Service)

- What is the current land use? With development we will most likely increase the impervious area and a correlating increase in stormwater runoff volume. As we saw in Module 4, MS-19 requires that a project discharges into an adequate channel and also defines channel adequacy.

1% rule	• **Channel is assumed to be adequate**
Natural Channel	• **2-year storm does not overtop bed and banks** • **2-year storm does not cause erosion of bed and banks**
Man-Made Channel	• **10-year storm does not overtop bed and banks** • **2-year storm does not cause erosion of bed and banks**
Stormwater Infrastructure (pipes)	• **Be able to handle the capacity of a 10-year storm**

The stormwater law and regulations that come into effect on July 1, 2014 require that the energy from post-development stormwater discharges is equal to or smaller than the pre-development energy of the discharge.

$$Q_{post} \leq I.F. \times (Q_{pre} \times RV_{pre})/RV_{post}$$ or

$$(Q_{post} \times RV_{post}) \leq I.F. \times (Q_{pre} \times RV_{pre})$$

Where

- Q_{pre} =Pre-development peak flow rate (cfs)
- RV_{pre} = Pre-development runoff volume (in.)
- Q_{post} = Post-development peak flow rate (cfs)
- RV_{post} = Post development runoff volume (in.)
- I.F. = Improvement factor (0.8 for sites>1 acre, 0.9 for sites < 1 acre

- Development usually flattens a site (cut and fill, see Figure 3) and these topographic changes may greatly impact the runoff from a site as well. It may also alter the size of drainage areas which in turn impact the choice in sediment control practices such as traps and basins (MS-6).

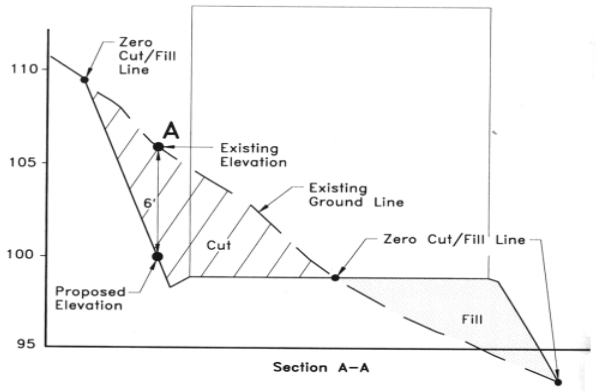


Figure 3. A proposed cut and fill operation on this slope will greatly flatten the area and impact stormwater runoff.

b. Surrounding properties

Areas, properties and streams are always in danger of being impacted by up-gradient development. As previously mentioned most sediment control practices are only 60% efficient in controlling sediment; very small particles (clay) cannot easily be captured by the non-proprietary sediment control measures and this inability is captured by the law when it mentions "unreasonable degradation".

The intent of the ESC Law and Regulations is to be protective of down-gradient resources and references to downstream properties, erosion impact areas, and environmentally sensitive areas stress this intent.

The stated intent of the law is "for the effective control of soil erosion, sediment deposition, and nonagricultural runoff to prevent the unreasonable degradation of properties, stream channels, waters and other natural resources"

The law and regulations do not define critical and environmentally sensitive area, but they include:

- State waters including wetlands, aquifers, springs, stream channels, creeks, rivers, lakes, and the Chesapeake Bay
- Steep slopes
- Areas containing threatened or endangered species or their habitat
- Sink holes, particularly in karst areas

Land disturbance in critical areas generally require the more costly sediment control measures; may require the highest maintenance cost; and may fail the quickest.

Slope Angle	Erosion Hazard	Critical After
0-7%	Low	300 ft.
7-15%	Moderate	150 ft.
>15%	High	75 ft.

The steepness or length of slope, will increase the erosion hazard

c. Ultimate development condition

Ultimate development of the site is an important item when developing an erosion and sediment control plan. It is important to note that per MS-19(e) "*all hydrologic analyses shall be based on the existing watershed characteristics and the ultimate development of the subject property.*"

In erosion and sediment control a site is split up in (1) impervious areas, (2) high maintenance areas, and (3) low maintenance areas. This split is done for post development and stabilization of the site, with the ultimate goal of meeting MS-3. Conversely, the current stormwater law and regulations recognize: (1) open space, (2) lawn and (3) impervious areas as part of the runoff reduction method. While there may appear to be some similarities between these two methods they cannot be used interchangeably. For example, while erosion and sediment control encourages the preservation (non-disturbance) of natural areas, it does not include these areas as low maintenance areas since they were not disturbed.

<u>High maintenance areas</u> are areas that require fertilization and regular mowing, including:

- Residential lawns
- Some commercial lawns
- Some recreational areas

<u>Low maintenance areas</u> include:

- Some commercial lawns
- Some recreational areas
- Grassed waterways
- Stream banks
- Areas not frequently mowed

Knowing the ultimate development of the site is also important in determining the placement of some of the ESC practices including tree protection fences and sediment traps and basins.

d. Development sequence

Phasing of the project is important in order to know when to install the controls. Generally per MS-4 perimeter controls are to be installed as a first step measure and followed by the stabilization of any of the earthen structures (MS-5). For larger, multi-year development sites, consideration may be given to the development in phases, thereby optimizing the use of ESC practices.

In many cases, sediment basins will be converted into stormwater basins after construction is complete, and the careful planning of these structures is important. This includes the location, size, routing of runoff to the basins, and timing of the conversion.

e. Potential erosion and sedimentation hot spots

As mentioned above, critical areas in land disturbance area can be considered erosion and sedimentation hot spots. Being aware of these areas is crucial in controlling sediment runoff. In addition knowing the drainage on a site will help you determine how runoff will travel over site and will provide you with specific treatment possibilities for these smaller sites. Sediment will leave these drainages at the lowest points and that is the location we want to prevent the sediments from leaving the site.

f. Measures to prevent erosion on site and sediment from leaving the site

Keeping in mind that erosion control is the first line of defense; the first measures coming to mind include:

- The preservation of existing vegetation
- Stabilize (seed and/or mulch) the site per Minimum Standards, 1, 5, 15, and 16.

If there is no erosion
there is no sediment

As mentioned above, erosion generally leaves a site by way of the site's lowest point, and when evaluating a site sediment control measures should target those areas. This is usually done with structural practices that are designed using Chapter 3 in the Erosion and Sediment Control Handbook.

g. Stormwater runoff considerations

Where increased runoff will cause the carrying capacity of a receiving channel to be exceeded, the site planner must select appropriate stormwater management measures (MS-19). Note that after July 1, 2014 the VSMP Law and Regulations need to be applied to this issue for areas >1 acre.

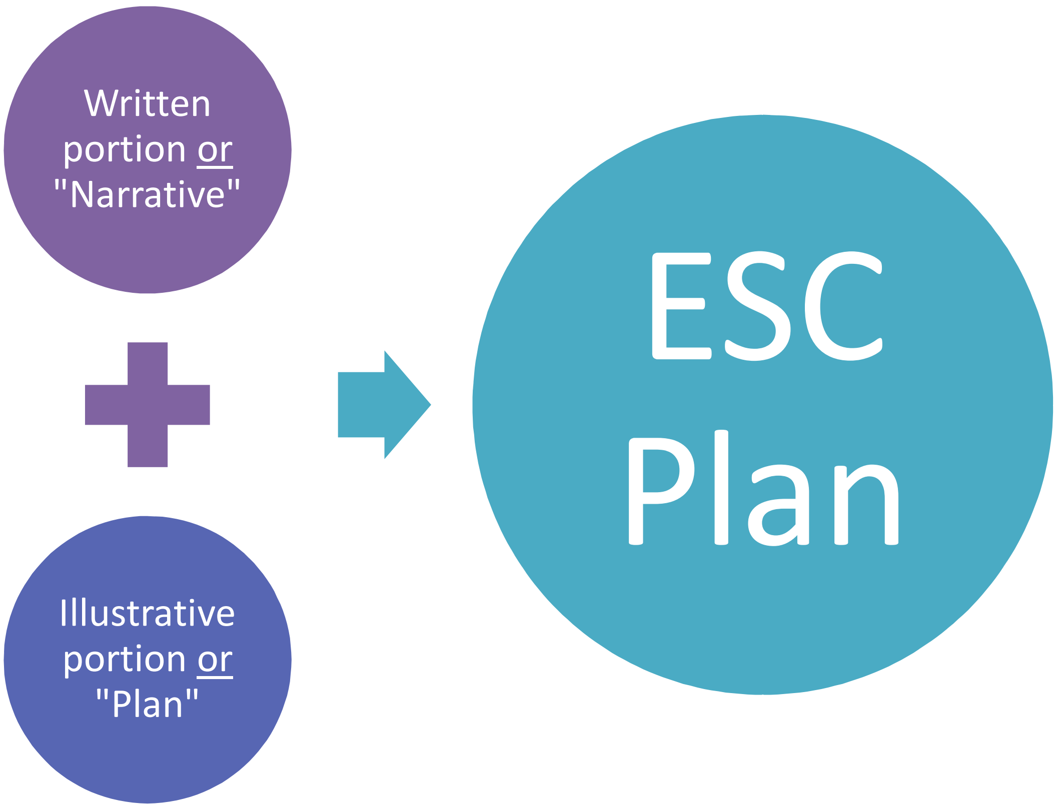
h. Maintenance during and post construction

Inspection and maintenance of the erosion and sediment control practices during construction is specified in Chapter 3 of the Erosion and Sediment Control Handbook. MS-19 and the VSMP Law and Regulations specify that all (post construction) stormwater structures are required to have a long-term maintenance plan.

6c. The Erosion and Sediment Control Plan

The plan preparer (owner) needs to understand that an ESC plan should be stand-alone part of the entire site development plan such as the construction drawings. The Plan Reviewer, Inspector, site supervisor and/or RLD should be able to use this independent plan to determine how the site is being developed without the need to consult the more detailed working or construction drawings. The E&S plan should show how the site is being developed, what is being proposed for the site, the sequencing and phasing of the construction (without being bogged down with details that might not be relevant to erosion and sediment control).

The Erosion and Sediment Control Plan consists of two parts: a written portion or the narrative and an illustrative portion or the plan. These will be discussed in more detail in Module 7.



6d. Vegetative Control Practices

The benefits of vegetative ground cover

When planning for erosion and sediment control, establishing ground cover should be one of the first steps that need to be considered in a land disturbance project. As previously mentioned, a good vegetative cover eliminates almost all potential for erosion. This is reflected in Minimum Standards 1, 3, and 5 which address this need to establish a ground cover directly. Minimum Standards 2 and 7 indirectly deal with groundcover (site stabilization) as well.

Benefits of vegetative cover:

- It is relatively inexpensive to establish and maintain compared to structural methods;
- It slows runoff and filters sediment;
- It protects the soil from raindrop impact;
- Plant roots bind the soil particles and enhance filtration and infiltration of runoff; and
- Dead plant materials get incorporated in the soil as organic matter, which improves soils structure and infiltration of runoff.

These minimum standards directly or indirectly deal with the establishment of vegetative cover on a site:

- MS-1 Stabilizing areas that are dormant
- MS-2 Stabilizing topsoil stock piles
- MS-3 Permanent stabilization
- MS-5 Stabilization of earthen structures
- MS-7 Stabilizing of cut and fill slopes

The most cost effective measure in controlling erosion from a site is to preserve existing vegetation. This can either be done in perpetuity and incorporating it in the post construction landscape design, or for a shorter period and carefully planning the phasing of a project.

Advantages of leaving undisturbed areas include:

- Minimization of development (clearing and grading) cost;
- Native vegetation is likely already mature and adapted to the local environment;
- Leaving a vegetative buffer strip around a project would help to filter any runoff before it leaves the property; and
- Soils that are not disturbed and not compacted have higher infiltration rates than surrounding areas that have been cleared.

Therefore, these undisturbed areas can be used as an inexpensive tool to assist in the management of stormwater during and post construction.

Chapter 3 of the Erosion and Sediment Control Handbook classifies practices 29 through 39 as vegetative (or erosion) control practices.

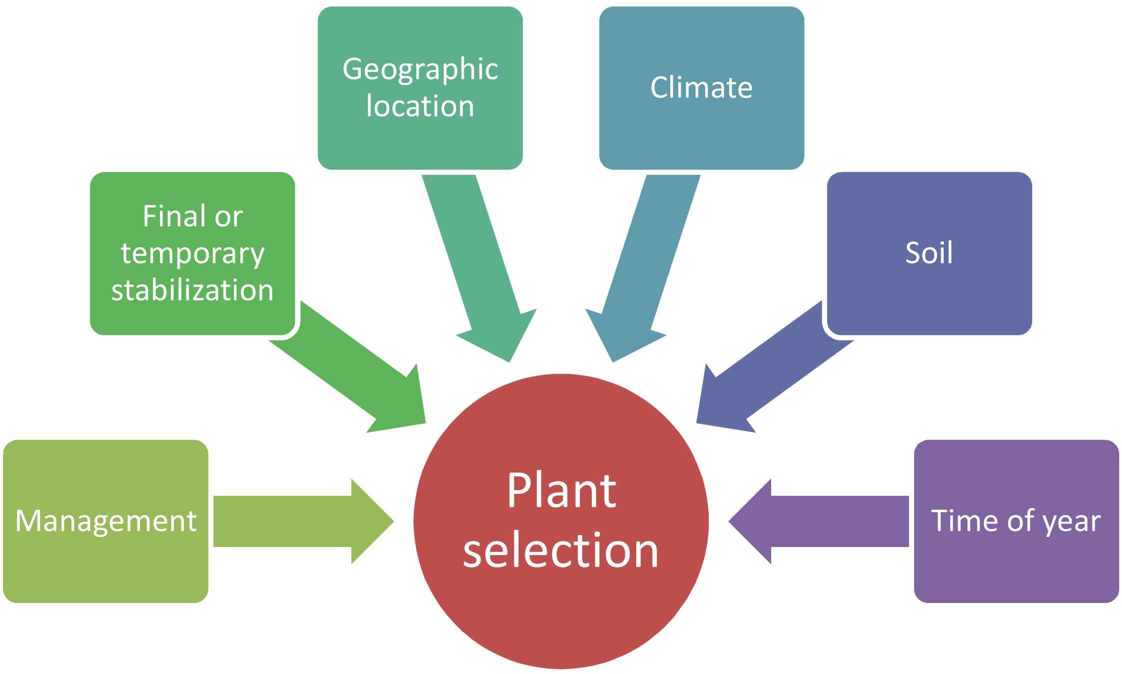
What influences plant selection?

As MS-3 states, all areas not otherwise permanently stabilized need have some kind of vegetative cover on them to prevent erosion. The "otherwise stabilized" includes buildings, roads, walkways, driveways, etc, in other words areas where you can see the bare soil need to be stabilized with a vegetative cover.

MS-3 A permanent vegetative cover shall be established on denuded areas not otherwise permanently stabilized. Permanent vegetation shall not be considered established until a ground cover is achieved that is uniform, mature enough to survive and will inhibit erosion.

As previously mentioned, in ESC we divide these areas into **High Maintenance Areas** and **Low Maintenance Areas.** High maintenance areas generally can be expected to receive high foot traffic and/or are frequently mowed. They are often heavily fertilized and management may include the application of pesticides and herbicides. Low maintenance areas are managed less intensively. Plant selection for these two types of land uses will be very different.

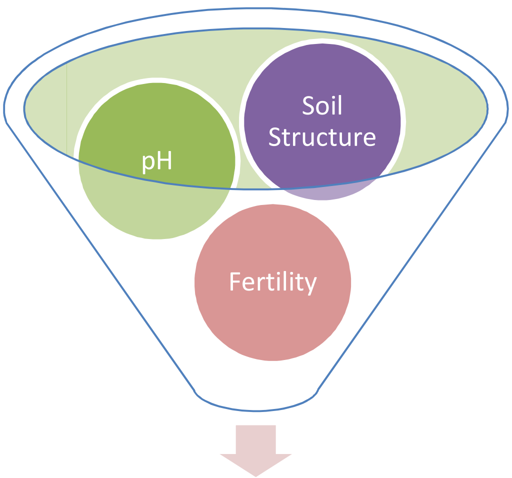
Other factors influencing Plan selection are shown on the next page.



What influences plant establishment?

Once the proper plant species are selected for the intended post development land use, it is time to get them established. This can be done by seeding, sodding, sprigging or planting (Practices 31, 32, 33, 34, and 37 in the Erosion and Sediment Control Handbook).

The overriding factor in getting proper plan establishment is providing them a good growing medium (or soil).



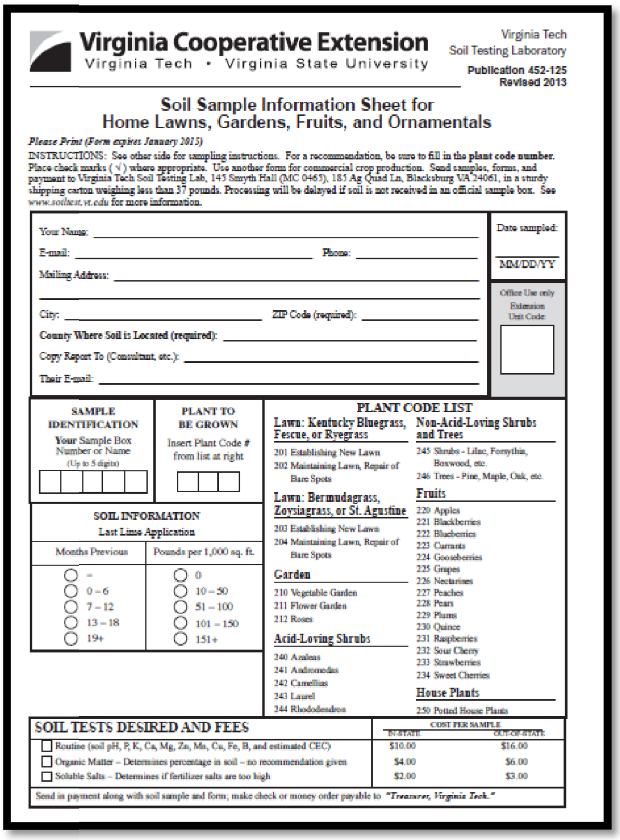
Good Soil and Plant Establishment

Soil testing: Soil testing is one of the most important steps in getting plants established (http://www.soiltest.vt.edu/Files/testing-process-and-fees.html). The fees for soil analysis are listed in Table 6-1. Virginia Tech analyzes the "routine tests packages for pH (or soil acidity), phosphorus (P), Potassium (K), Calcium (Ca), Magnesium (Mg), Zinc (Zn), Manganese (Mn), Copper (CU), Iron (FE), Boron (B), and Cation Exchange Capacity (CEC), and it will give a fertilizer and lime recommendation.

Table 6-1. Virginia Tech soil test fees

CHARGES per sample	(In-State)	(Out-of-State)
Routine Test Package	$10.00*	$16.00
Soluble Salts	$2.00	$3.00
Organic Matter	$4.00	$6.00
FAX results:	$1.00	$2.00

* No charge for in-state commercial farm samples


Virginia Cooperative Extension
Virginia Tech • Virginia State University

Virginia Tech
Soil Testing Laboratory
Publication 452-125
Revised 2013

Soil Sample Information Sheet for
Home Lawns, Gardens, Fruits, and Ornamentals

Please Print (Form expires January 2015)

INSTRUCTIONS: See other side for sampling instructions. For a recommendation, be sure to fill in the plant code number. Place check marks (√) where appropriate. Use another form for commercial crop production. Send samples, forms, and payment to Virginia Tech Soil Testing Lab, 145 Smyth Hall (MC 0465), 185 Ag Quad Ln, Blacksburg VA 24061, in a sturdy shipping carton weighing less than 37 pounds. Processing will be delayed if soil is not received in an official sample box. See *www.soiltest.vt.edu* for more information.

Your Name: ____
E-mail: ____ Phone: ____
Mailing Address: ____
City: ____ ZIP Code (required): ____
County Where Soil is Located (required): ____
Copy Report To (Consultant, etc.): ____
Their E-mail: ____

Date sampled: ____ MM/DD/YY

Office Use only
Extension Unit Code:

SAMPLE IDENTIFICATION
Your Sample Box Number or Name
(Up to 5 digits)

PLANT TO BE GROWN
Insert Plant Code # from list at right

SOIL INFORMATION
Last Lime Application

Months Previous	Pounds per 1,000 sq. ft.
○ –	○ 0
○ 0 – 6	○ 10 – 50
○ 7 – 12	○ 51 – 100
○ 13 – 18	○ 101 – 150
○ 19+	○ 151+

PLANT CODE LIST

Lawn: Kentucky Bluegrass, Fescue, or Ryegrass
201 Establishing New Lawn
202 Maintaining Lawn, Repair of Bare Spots

Lawn: Bermudagrass, Zoysiagrass, or St. Agustine
203 Establishing New Lawn
204 Maintaining Lawn, Repair of Bare Spots

Garden
210 Vegetable Garden
211 Flower Garden
212 Roses

Acid-Loving Shrubs
240 Azaleas
241 Andromedas
242 Camellias
243 Laurel
244 Rhododendron

Non-Acid-Loving Shrubs and Trees
245 Shrubs - Lilac, Forsythia, Boxwood, etc.
246 Trees - Pine, Maple, Oak, etc.

Fruits
220 Apples
221 Blackberries
222 Blueberries
223 Currants
224 Gooseberries
225 Grapes
226 Nectarines
227 Peaches
228 Pears
229 Plums
230 Quince
231 Raspberries
232 Sour Cherry
233 Strawberries
234 Sweet Cherries

House Plants
250 Potted House Plants

SOIL TESTS DESIRED AND FEES	COST PER SAMPLE IN-STATE	COST PER SAMPLE OUT-OF-STATE
☐ Routine (soil pH, P, K, Ca, Mg, Zn, Mn, Cu, Fe, B, and estimated CEC)	$10.00	$16.00
☐ Organic Matter – Determines percentage in soil – no recommendation given	$4.00	$6.00
☐ Soluble Salts – Determines if fertilizer salts are too high	$2.00	$3.00

Send in payment along with soil sample and form; make check or money order payable to *"Treasurer, Virginia Tech."*

Figure 1. Example of the order form for the soil analysis by the Cooperative Extension Service at Virginia Tech.

Soil Structure: On a typical construction site the site is cleared, the topsoil is often stripped to expose the more stable subsoil and, with some projects, the topsoil is spread over the bare subsoil once construction has been completed. During construction, the subsoil is compacted by construction vehicles, increasing the bulk density of the soil close to that of concrete (Table 6-2 and Figures 1 and 2).

Soils with such a high bulk density have low infiltration rates, meaning water cannot enter the soil as readily, and they become impenetrable to plant roots and plants will have a difficult time becoming established.

Figure 2. Compacted Soil
(Source: Center for Watershed Protection)

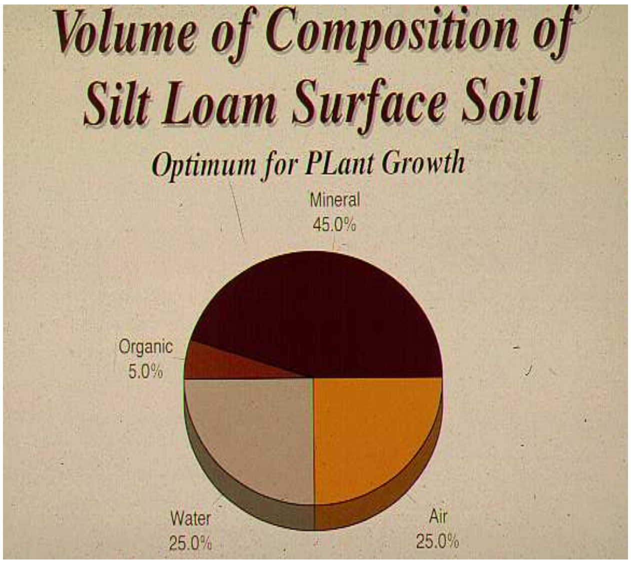


Figure 3 (left). Ideal volumetric composition of a soil

Table 6-2
Common Bulk Density Measurements

Land Surface/Use	**Bulk Density**
Undisturbed Lands Forest & Woodlands	1.03 g/cc
Residential Neighborhoods	1.69 to 1.97 g/cc
Golf Courses - Parks Athletic Fields	1.69 to 1.97 g/cc
Concrete	2.2 g/cc

Proper preparation of the soil prior to planting is essential for good plant establishment!

pH or Acidity of the Soil: Soils in Virginia are generally acidic, meaning they have a low pH (Figure 4). They generally range between 4.0 and 8.0; however, the majority of Virginia's soils are between 5 and 6.5; the average pH of soils in forested areas in Virginia was reported to be below 5.0*. Agriculture crops and our landscaping plants grow best when the soil pH is between 5.8 and 6.8.

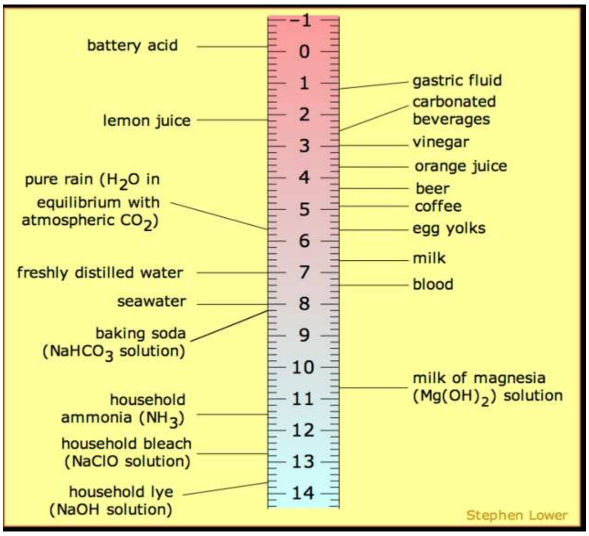


Figure 4. The pH (acidity) of some common household items

The application of lime is the best method to raise the pH in the soil.

Fertility: Plants need nutrients to grow. While a lot of these nutrients are available in the soil, the three macro-nutrients Nitrogen (N), Phosphorus (P) and Potassium (K) are often in short supply in the soils and need to be added as fertilizer. Addition of these nutrients should be based on recommendations resulting from a soil analysis.

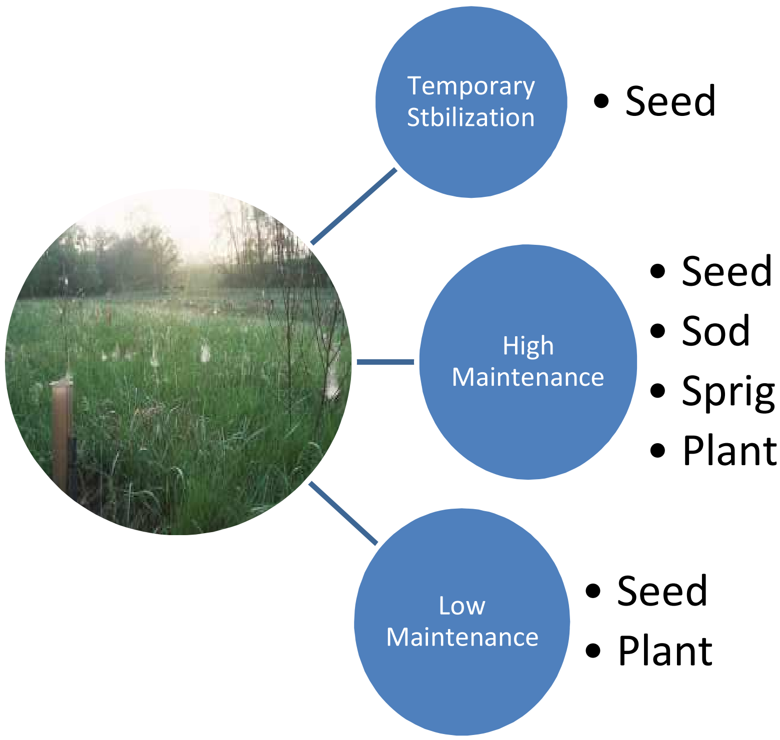
Figure 5. All fertilizers have three numbers on the bag like this one. These numbers stand for the total percentage N, P, and K (or N-P-K). This bag has 12% Nitrogen (by weight), 3% Phosphorus and 10% Potassium. A 50 lbs bag of this fertilizer will therefore have 6 lbs of nitrogen, 1.5 lbs Phosphorus and 5 lbs of Potassium.

* (A.K. Ross. 2006. Soil Conditions Across Virginia, 2000-2002, http://fhm.fs.fed.us/posters/posters06/soil_cond_va.pdf).

Plant Selection and Planting Method

As we have seen previously plant selection depends on a multitude of factors, including: management, whether we are considering final or temporary stabilization, geographic location, climate, soil, and time of year of planting. The following two figures show some of the planning considerations when selecting plants. For example, temporary stabilization is usually by seeding, while permanent stabilization has methods available to achieve final stabilization. However, one of the first considerations with permanent stabilization will be whether we have a high or low maintenance area. Low maintenance areas generally require less input from the developer, unless the plan calls for the planting of trees and shrubs.

If an area cannot be seeded within the time required by MS-1 for reasons such as: frost, or drought; the site must still be stabilized. The "go to" method in these cases is mulch.



When considering seeding of grasses we need to choose between annuals or perennials and between cold season and warm season grasses. Annuals live for one year or one season and are usually used with temporary seeding. If an area is not at final grade but will be left dormant for more than one year it needs to be seeded with perennial plants (MS-1). Under normal conditions, perennials live more than one year.

Warm season species are species that go dormant during the winter and cannot be sown or planted when frost is possible within 12 weeks of seeding. Cold season grasses may go dormant in the hot summer months because of the heat and when there is a lack of irrigation.

Sodding is typically done with cold season grasses; warm season grasses are either established through seeding, sprigging or plugging. Note that is both cases the plants need to by planted within 36 hours of harvesting.

Seeding

- Temporary → annuals
- Permanent → perennials
- *Land use*
- *Certified seed*
- *Seed mix*
- *Time of year requirements*

Sodding

- Permanent
- *VCIA Certified*
- *Planted within 36 hours of harvesting*

Sprigging/ Plugging

- Permanent warm season grasses → Bermuda grass and Zoycha grass
- *VCIA Certified*
- *Planted within 36 hours of harvesting*

Planting

- Containorized
- Ball and burlap
- Bare Root

Top Soil and Seedbed Preparation

Topsoil is the surface horizon (layer) of the soil profile. It is generally characterized by a darker color, than the subsoil. This is due to the organic matter accumulation in the topsoil. The topsoil is the layer of the soil with most biological activity, water and nutrients required for plant establishment. Topsoil is therefore recommended for use in high maintenance areas.

As an alternative, when properly limed and fertilized, the subsoil can serve as a good substitute for topsoil, particularly for low maintenance areas. Below is a list of some of the advantages and disadvantages of topsoil use.

Topsoil

- Original soil
- Soil (micro)organisms
- Good growing medium
- Nutrients
- High water holding capacity
- Low bulk density
- Organic matter

Topsoil

- Stock piling (takes up space)
- Requires more time to strip, stock pile and reapply
- Increased exposure time of denuded areas
- Weed seeds

When topsoil is being used we need to make sure that:

- We have a place to store the topsoil and stabilize it during construction, per MS-2;
- We have enough topsoil to spread a layer that is 2 to 4 inches deep;
- We allow time for spreading and bonding; and
- We do not place it on a subsoil with too much of a contrasting texture.

Seedbed/planting bed preparation is an important step in getting the soil ready for planting. Seedbed or planting bed preparation is the most important item in plant establishment, regardless whether we spread topsoil or not. Seedbed or planting bed preparation includes tilling, fertilizing, liming, adding organic amendments, seeding, planting and mulching. Soils should be crumb like after tilling, and not too powdery or too hard. Fertilizing and liming should be done per recommendation from the soil test. The addition of organic amendments or other soil conditioners is optional, but is strongly recommended in some cases in particular when seeding in subsoil, or very heavy, compacted soil. Seeding can be done by broadcasting the seed, with a seed drill, or with a hydro-seeder. Mulching is generally done with straw (2 tons per acre). Other mulches include wood chips, wood fiber and bark, although these are usually used in perennial planting beds. When seeding is done with a hydro-seeder, the mulch maybe included in the mixture; in that case mulch consists of a poly acrylamide, a gum, or a cellulose-like material that contains a binder. These materials are also known as tackifiers.

Organic amendments and soil conditioners include:

- Peat
- Sand
- Vermiculite
- Raw manure
- Rotted saw dust
- Treated sewage
- Compost

Minimum Standards that address slopes and slope stability:

MS-7 Cut & Fill Slopes
MS-8 Concentrated Runoff
MS-9 Water Seeps

Revegetating (seeding) slopes may require varying techniques depending on the steepness. Slopes are generally more erosive and have three dedicated minimum standard that address them. Seedbed preparation of slopes include tracking up and down to create small depressions that slow down the runoff and allow seeds to germinate.

Figure 6. This slope has been tracked in the correct way and is now ready to be seeded and mulched.

Plant Materials

Temporary seeding is usually done with annuals, meaning plants that live for one season to one year maximum. Temporary seeding is often done to establish a temporary cover on areas not at final grade but left without disturbance for more than 14 days (per MS-1) or in areas where permanent seeding is temporarily not possible (i.e., areas that come to final grade in winter but need to have a cover of warm season grasses). Section 3.31 in the ESCHB provides the standards and specifications for temporary seeding. The table below lists the species in the 1992 Handbook.

Species	Summer Planting	Fall/Winter Planting	Spring Planting	Remark
Oats	No	No	Yes	
Rye	No	Yes	No	
German Millet	Yes	No	No	
Annual Ryegrass	No	Yes	Yes	
Weeping Lovegrass	Yes	No	No	Short lived perennial
Korean Lespedeza	Yes	No	Yes	

Weeping lovegrass and Korean lespedeza are listed by the U.S. Department of Agriculture as potentially non-native invaders and may need to be used with some caution (http://www.plants.usda.gov/factsheet/pdf/fs_ercu2.pdf and http://www.plants.usda.gov/factsheet/pdf/fs_kust.pdf).

Permanent seeding is usually done per recommendation from the landscape architect or planner of the project; it is usually very land use specific. Section 3.32 in the ESCHB provides a list of potential species that can be used in planning a landscape. Some of the more common species are: tall fescue, Kentucky bluegrass, perennial ryegrass, red fescue, red top, crown vetch and some of the lespedezas. Seed companies have developed a "contractor's mix", which is a blend of the different species listed above. These "contractor's mixes" are designed to get a quick and diverse cover and take the guess work out of trying to blend a number of species; however, they are not site-specific.

Please note that some of the species or cultivars mentioned in the 1992 ESCHB may have been discontinued; may have been improved; seed mixtures may have been changed (VDOT has developed a specific roadside wildflower mix http://www.virginiadot.org/programs/prog-wflowr-faqs.asp for use along the interstates); or as is seen in some cases, they were found to be invasive. We recommend that when in doubt you consult your local extension office or soil and water conservation district for an up-to-date recommendation for species selection. Appendix A to this module provides you with a publication on the use of native species versus introduced species.

Species that may be invasive or may be over-used

- Chinese lespedeza
- Birdsfoot trefoil
- Orchard grass
- Redtop
- Weeping lovegrass
- Crownvetch
- Tall fescue
- (Kentucky bluegrass)

Potential alternative/additional native species for use in low maintenance areas

- Roundheaded bushclover
- Partridge pea
- Butterfly weed
- Joe-pey weed
- Orange coneflower
- Big blue stem
- Indian grass
- Side oats grama
- Switch grass
- Broom sedge
- Deertongue
- Canadian wildrye
- Bottlebrush grass
- Virginia wildrye

Sodding

Sodding is usually only done only in high maintenance areas or areas that require instant cover including ditches and swales. Soil preparation, liming and fertilizing for sodding is very similar as for seeding. However, soils need to be smooth, free of rocks, boulders and other pieces of debris. Sod needs to be place within 36 hours of harvesting at the sod farm. When placing the sod, soils should not be soggy, excessively dry, hot or frozen. When placing sod on a slope or in a waterway it needs to be placed in staggered rows and stapled. The figure below provides a comparison between seeding and sodding.

Seeding	Seeding	Sodding	Sodding
Positive	**Negative**	**Positive**	**Negative**
• Low cost • Wide range of species selection • Low labor requirement • Easy establishment in areas with low accessibility	• High innitial erosion potential • Area unusable early on • Establishment may be poor (reseeding) • Weeds • Seasonal limitations • Watering requirements for germination • Quality of seed and vegetation not certain	• Imediate results/ erosion, dust, mud control • Can be established almost year-round • No weeds • Area can be used quickly after sodding • Less prone to failure	• Limited species selection and diversity • Expensive • Difficult to sod inaccesible places • Warm soil in summer may reduce establishment of cool season grasses • Watering requirements for establishment

Bermudagrass and Zoysiagrass

Both Bermuda and Zoysia are warm season grasses. They are usually planted using sprigs, stolons or plugs. Once planted, they form a dense mat in 8 to 12 weeks. Therefore, being a warm season grass they need to be planted between May 1 and July 15. Planting outside these dates will result in insufficient establishment or complete failure. We therefore recommend seeding with a temporary cover to carry the site over until these grasses can be planted.

Mulching

Mulches may be defined as non-soil substances that are applied to the soil to conserve desirable soil properties and/or promote plant growth. They are often plant based including:

- Straw
- Hay
- Corn stalks
- Wood chips
- Shredded bark/bark chips
- Fiber products

Additional materials include blankets and netting. Advantages of these products are:

- **Protect the soil from raindrop impact**
- **Prevents soils crusting**
- **Increases the infiltration rate of the soil**
- **Reduces soil moisture loss**
- **Modifies soil temperatures**
- **Provides a suitable microclimate for seed germination and plant establishment**
- **Provides organic matter to the soil**

Chemical binders are best used to anchor the organic mulches since they have been found to be ineffective in providing these advantages.

6e. Structural Control Practices

While vegetative controls are considered the first line of defense, structural controls can be considered the second line of defense. Structural controls are meant to filter water leaving a construction site and remove the sediments that could not be kept from eroding. They are in most cases not more than 60% efficient in containing sediment, and the smaller particles such as clays will be very difficult to filter out. Structural controls are generally also more expensive than vegetative methods. Chapter 3 in the 1992 ESCHB is organized in such a way that it groups certain practices (below).

1 Safety Fence

2-3 Road Stabilization
- Construction Entrance
- Construction Road Stabilization

4-8 Sediment Barriers
- Straw Bale Barrier
- Silt fence
- Brush Barrier
- Storm Drain Inlet Protection
- Culvert Intlet Protection

9-12 Dikes and Diversions
- Temporary Diversion Dikes
- Temporary Fill Diversions
- Temporary Right-of-Way Diversions
- Diversions

13-14 Sediment Traps and Basins
- Temporary Sediment Trap
- Temporary Sediment Basin

15-16 Flumes
- Temporary Slope Draines
- Pave Flumes

17-21 Waterway and Outlet Protection
- Stormwater Conveyance Channel
- Outlet Protection
- Riprap
- Rock Check Dams
- Level Spreader

22-27 Stream Protection
- Vegetative Streambank Stabilization
- Structural Streambank Stabilization
- Temporary Vehicular Crossing
- Utility Stream Crossing
- Dewatering Structures
- Turbidity Curtain

28 Subsurface Drain

Road stabilization practices prevent the tracking of dirt onto public roads, while sediment barriers filter sediment laden water. Dikes and diversion either split up drainage area, reduce them in size or prevent stormwater from entering an area. Sediment traps and basins filter water prior to discharge. Flumes allow stormwater to safely flow down slopes. Waterway, outlet and stream protection protect onsite channels, outlets and off-site channels, respectively. Finally, excess water on a site can also be removed by subsurface drain.

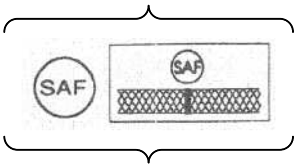
Each chapter (practice) in Section 3 of the ESCHB is organized a number of sections:

1. Definition
2. Purpose
3. Condition where practice applies
4. Planning considerations
5. Design criteria
6. Construction specifications
7. Maintenance

DEQ realizes that there are many more sediment control measures on the market. These measures are almost all proprietary and are not discussed in the ESCHB. The practices in the 1992 ESCHB are generic and non proprietary. If a proponent of a project wishes to use a proprietary practice, this practice will need to be approved for use in that locality. Approval is done at the locality level, often in consultation with the local DEQ representative.

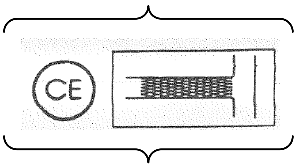
The following is a brief review of some selected sediment control practices:

3.01 Safety Fence (SAF)



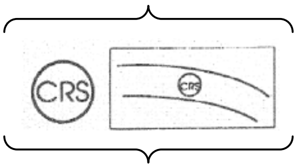
Safety fences are not a structural E&S practice. However, they are placed on the perimeter of a project to protect the public and prevent access to the project by the public. Increasingly it may be used to protect areas to be left undisturbed on a construction site.

3.02 Temporary Stone Construction Entrance (CE)



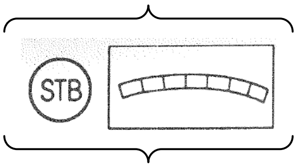
Construction entrances are stone pads located at the points of vehicular ingress and egress on a construction site. They are meant to reduce the transportation of soil onto public roads and other paved areas. In some cases a wash rack may be needed to improve the effectiveness of a construction entrance. This practice addresses MS-17, which requires that a project minimizes the transportation of sediment by vehicular traffic onto pave surfaces. MS-18 requires the removal of construction entrances after completion of a project.

3.03 Construction Road Stabilization (CRS)



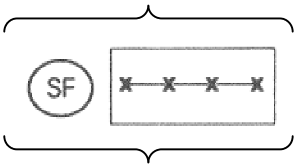
This practice is also used to address MS-17. During wet weather, temporary stabilization with stone would reduce the mud and potential erosion that would be generated and transported from recently graded access roads, subdivision streets, parking areas and other traffic areas.

3.04 Straw Bale Barrier (STB)



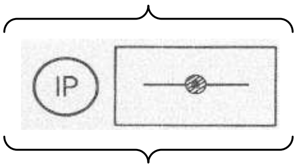
Straw bales are a somewhat outdated method of intercepting sheet and rill flow from small drainage areas. As perimeter control they often installed as a first step measure (MS-4) and placed across or at the toe of a slope. Straw bales need to be entrenched and care needs to be taken that they are installed on contour in order to avoid undercutting. Straw bales and silt fences (Practice 3.05) have a total drainage area limitation of ¼ acre to 100 linear feet of barrier; meaning, the total drainage area behind a straw bale barrier and silt fence cannot be wider that 100 feet. They need to be removed at the end of a project per MS-18. Finally, straw bales should not be used as check dam.

3.05 Silt Fence (SF)



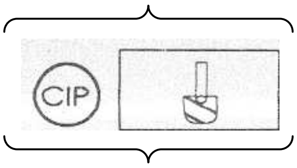
A silt fence is a temporary sediment barrier constructed of filter fabric and supported by pests and sometimes wire. Like straw bale barriers (3.04) they are used to intercept sheet and rill flow from small drainage areas. As perimeter control they often installed as a first step measure (MS-4) and placed across or at the toe of a slope. Silt fences have a total drainage area limitation of ¼ acre to 100 linear feet of barrier; meaning, the total drainage area behind a silt fence cannot be wider that 100 feet. They need to be removed at the end of a project per MS-18. Finally, silt fences can be used in concentrated flows, under low energy situations of less than 1 cubic foot per second (cfs).

3.07 Storm Drain Inlet Protection (IP)



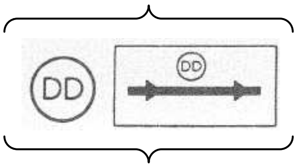
The 1992 ESCHB shows the specifications of numerous types of storm drain inlet protection including drop inlets and curb inlets. MS-10 requires that inlet protection is provided on all inlets that are operational before final/permanent stabilization of the area. Drainage area size limitation is 1 acre and inlet protection needs to be removed at the end of a project per MS-18.

3.08 Culvert Inlet Protection (CIP)



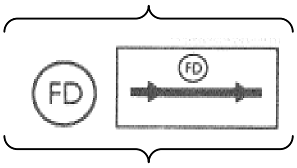
Culvert inlet protection includes a sediment filter in front of a culvert to prevent sediment from entering into the culvert. This includes protection around the culvert prior to final stabilization. Culvert inlet protection is required by MS-10 and needs to be removed at the end of the project (MS-18).

3.09 Temporary Diversion Dike (DD)



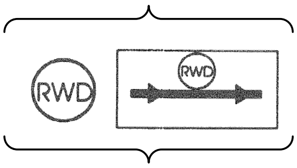
This is a ridge of compacted soil which is either used to divert water away from the project area, or divert water on-site to sediment trapping devises, water conveyances, or stabilized outlets (MS-11). Temporary diversion dikes can be constructed as first step measures (MS-4) or later on when site conditions change. They have a maximum drainage area size of 5 acre. These practices need to be stabilized immediately after construction (MS-5), and they have a maximum life of 18 months.

3.10 Temporary Fill Diversions (FD)



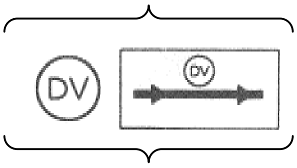
This is a diversion used for active (earth) fill areas. They address MS-7 in requiring stable fill slopes that are non-erodible and MS-8 which requires that any concentrated runoff be taken down the slope in a controlled fashion. Temporary fill diversions are typically constructed at the end of the work day; they have a maximum life span of one week, and therefore do not need to be stabilized. They are constructed in such a way that water is diverted from the slope to a stable outfall (MS-11).

3.11 Temporary Right-of-Way Diversions (RWD)



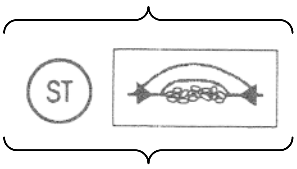
This is a ridge of compacted soil or loose gravel placed across a disturbed right-of-way. It is often seen on utility projects in hilly terrain. They are constructed to reduce the flow length and divert the water to a stable outlet (MS-11).

3.12 Diversion (DV)



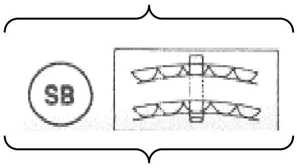
This is a permanent channel with a ridge on the lower (downslope) side. They are constructed to reduce slope length, divert stormwater runoff and are sometimes used as perimeter control. They must outfall in a stabilized outlet (MS-11) and must be designed to convey the runoff from a 10-year storm (MS-19). MS-5 requires that they are stabilized prior to being made operational.

3.13 Temporary Sediment Trap (ST)



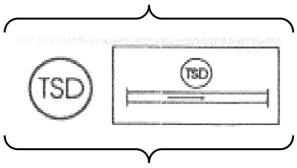
This is a small ponding area usually formed by constructing a earthen embankment along a slope or small drainage area. It has an area for dry storage and wet storage. A stone weir/outlet is used to drain to drain this pond over a defined time. Per MS-6 they can only treat runoff from small drainage areas (less than 3 acres). They are generally used as part of the perimeter controls for the project (MS-4) and need to be stabilized before made functional (MS-5). Maximum lifespan is 18 months.

3.14 Temporary Sediment Basin (SB)



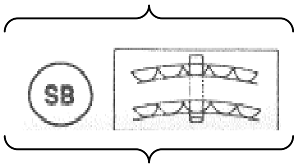
Sediment basins are used to treat sediment laden stormwater runoff from areas that are 3 acres or larger (MS-6). They consist of a temporary barrier or dam with an engineered outfall structure that releases the water in a controlled fashion. Sediment basins have an area for dry storage and wet storage. The dam is usually constructed across a drainage way at the low end of the project and should be designed by a qualified professional. They are generally used as part of the perimeter controls for the project (MS-4) and need to be stabilized before made functional (MS-5). Maximum lifespan is 18 months.

3.15 Temporary Slope Drain (TSD)



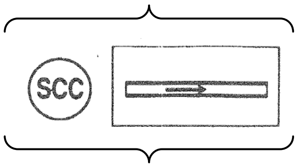
Temporary slope drains consist of flexible tubing that are installed on slopes and conduct concentrated runoff safely from the top to the bottom of the slope without causing erosion on or below the slope. They are required per MS-8.

3.16 Pave Flumes (PF)



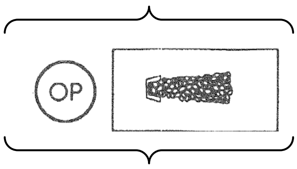
Paved flumes are permanently concrete lined channels constructed to conduct concentrated stormwater runoff from the top to the bottom of a slope without causing erosion on or below the slope. They are required per MS-8.

3.17 Stormwater Conveyance Channels (SCC)



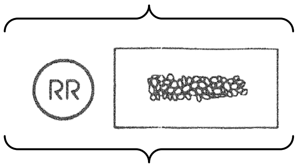
These are permanent channels designed to carry concentrated flow without erosion. They are sometimes designed in combination with (permanent) diversions (3.12). They are designed to convey the quantity of water expected form a 10-year storm (MS-19) and need to be stabilized before being made operational (MS-5). This practice is applicable to all man-made (improved) channels includes road-side ditches, and natural channels that are or need to be improved as a result of the land development project, with the exception of channels that were designed using natural channel design practices (MS-19).

3.18 Outlet Protection (OP)



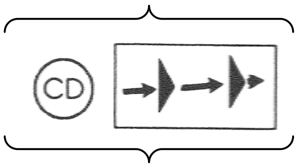
MS-11 requires outlet protection in areas where stormwater either leaves the project site or exits channels, stilling basins and/or (storm drain) outlets to reduce the erosive force of water by providing protection and reduce flow velocities before water enters the receiving channel below these outlets.

3.19 Riprap (RR)



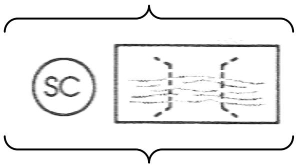
This is a permanent erosion-resistant ground cover of large, loose angular stone installed in situations where the erosive force of water turbulence and velocity cannot be controlled by other means including vegetative cover or netting and mats. Potential locations include drainage ways and slopes.

3.20 Rock Check Dam (CD)



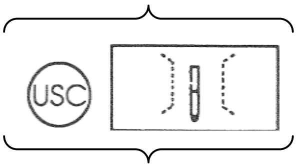
These are small temporary stone dams constructed across drainage ditches to reduce the velocity of concentrated flows and thus reducing the potential for erosion in swales and ditches. Check dams are removed at the end of a project.

3.24 Temporary Vehicular Stream Crossing (SC)



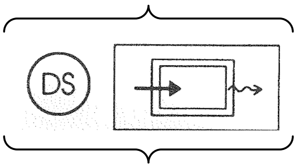
Temporary vehicular stream crossings are meant to provide access to construction activities on either side of the stream while protecting the stream from erosion and sedimentation by preventing damage to the stream's bed and banks. These temporary structures are constructed across live streams in compliance with MS-13.

3.25 Utility Stream Crossing (USC)



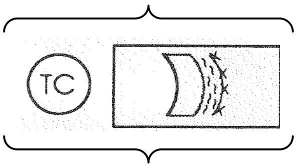
This is one of many possible strategies for crossing small waterways when in-stream utility construction is involved. It is done to minimize construction (disturbed area) in a stream; prevent sediment for entering the stream; and stabilize the disturbance footprint.

3.26 Dewatering Structure (DS)



These are temporary settling and filtering devices for water that is discharged from dewatering (pumping) activities. These structures need to be designed according to pump capacity.

3.27 Turbidity Curtain (TC)



Turbidity curtains are floating geo-textile curtains that minimize the sediment movement from a disturbed area adjacent or in a body of water. It prevents sediment from contaminating the entire water body and can only be used in areas with little or no channel flow.

Appendix: Invasive Plant Species

What is a Native Species?

Native species are those that naturally occur in the region in which they evolved. Plants evolve in specific habitats over extended periods of time in response to physical and biotic habitats processes that are characteristic of that place: the climate; the soils; the seasonal rainfall, drought, and frost and interactions with other species occupying those habitats. Native species thus possess certain traits that enable them to thrive under local conditions.

What Are Invasive Mien Species and Why Are They of Concern?

Alien plants, also known as exotic or non-native, are species that have *been* introduced intentionally or accidentally by human activity into a region in which they did not evolve. Many alien species are well known and economically important in agriculture and-horticulture, such as wheat, soybeans, and tulips: However, while some alien plants are beneficial and have little capacity to spread in the natural environment, a few are *invasive* and pose serious threats to both natural communities and rare species. Because of a lack of natural controls like insect pests and competitors, some invasive alien plants may escape cultivation, displace native plant species, reduce wildlife habitats, and alter ecosystem processes. The majority of invasive alien plants are problematic due to their ability to easily and rapidly disperse across the landscape. Given this possibility of colonization, use of these species for erosion and sediment control should be avoided when possible.

How Many Invasive Alien Plant Species Have Been Identified in Virginia?

Of the 4,000 alien plant species that have become naturalized in the U.S., approximately 400 are serious invaders. The Natural Heritage Program and the Virginia Native Plant Society, in cooperation with land managers and agencies, nurserymen, landscape architects, horticulturalists, and other partners, have identified 114 invasive alien plant species that threaten natural areas, forests, parks, and other conservation areas in Virginia. A complete list of invasive alien plants for Virginia is available on DNI-I's website.

Have Invasive Alien Plants Been Recommended for Vegetative Stabilization by the State?

Yes. There are seven plant species considered invasive aliens that are currently advocated for vegetative stabilization in the *Virginia Erosion and Sediment Control Handbook*. Chinese lespedeza *(Lespedeza cuneata)* and weeping lovegrass *(Eragrostis curvaula)* are recommended for Temporary Seeding (STD&SPEC 3.31), while Chinese lespedeza, crownvetch *(Coronilla varies), tall* fescue *(Loll= elatior* or *pratense),* birdsfoot trefoil *(Lotus corniculatus),* orchardgrass *(Dactylic glomerata),* and redtop *(Agresti gigantea)* are recommended for Permanent Seeding (STD&SPEC 3.32). Chinese lespedeza, tall fescue, and redtop are recommended for Stormwater Conveyance Channels (STD&SPEC 3.17), tall fescue and redtop for Vegetative Streambank Stabilization (STD&SPEC 3.22), and tall fescue for Sodding (STD&SPEC 3.33). However, DEQ encourages the use of native plants whenever feasible. More information is available at:

http://www.deq.virginia.gov/Portals/0/DEQ/Water/Publications/NativeInvasiveFAQ.pdf

Should Any of the Invasive Plants in the Handbook Be Avoided Entirely?

Yes. DEQ strongly discourages the use of Chinese lespedeza since it is highly invasive, and there are equally effective alternatives that are less problematic. It is especially important to avoid Chinese lespedeza in stormwater channels and on stream banks, as planting in these habitats may facilitate their wider distribution.

What Criteria Should Be Met For Native Species To Be Used for Stabilization?

The plant species chosen for stabilization must always be matched to the characteristics (climate, soils, etc.) of the site/region and must be commercially available in that region. Further, because interest in using native species for erosion and sediment control is relatively recent, alternative native species may, not have been thoroughly field-tested to document their efficacy for erosion and sediment control. DCR recommends native plants for vegetative stabilization if the following criteria *are* met:

1) Slopes < 15% slope gradient
2) Soils with K factors < 036 (soils are not highly erodible).
3) For use along roadways, species height must comply with Virginia Department of Transportation visibility requirements and not have characteristics that are highly attractive to birds and mammals
4) For use on stormwater conveyance channels and streambanks, species must have proven effectiveness at the expected maximum stormwater flow volume and velocity

Generally, flat to gently sloping, open areas where there is little traffic are appropriate locales for planting most of the alternatives species suggested below. Utility easements or rights-of-way, park like areas, greenways, and other open tracks of land are excellent places to propagate native plants. However, natives may be considered *even* if one of these criteria is not met if there is sufficient evidence that the species is effective for erosion control.

Are There Other Considerations When Employing Alternative Native Plants?

Yes. The following potential issues should also be considered when employing alternative native plants:

- Always using a seed mix is desirable for two reasons:
    - Some natives take several seasons to fully establish, so a seed mix including some non-competing annual plant species is recommended
    - To prevent establishing a "monoculture' and encourage biodiversity, multiple natives species should be established on site when possible

- Some natives have new/unique maintenance requirements (weeding, mowing, herbicides, etc.)
- Adding compost to raise the organic content of the soil will greatly enhance the success of vegetation
- Always coordinate with and educate local government officials, property owners, and the citizenry about the benefits of natives — many natives don't produce lush green lawns, and are perceived as weeds

What are Some Alternative Native Species to the Invasive Aliens in the Handbook?

The table below provides a list of alternative Virginia native plants with similar attributes to the invasive alien plants. These alternatives are offered as suggestions if the criteria listed above are met. Fact sheets for 30 invasive plant species and five brochures on using native plants for restoration and landscaping are available on DNH's website.

Invasive Alien Species	*Alternative Virginia Native*	
Common Name	*Common Name*	*Scientific Name*
Chinese lespedeza Birdsfoot trefoil Orchard grass Redtop Weeping lovegrass	Roundheaded bushclover	*Lespedeza capitata*
	Patridge pea	*Chamaecrista fasciculata*
	Butterflyweed	*Asclepias tuberosa*
	Joe-pye weed	*Eupatorium dubium*
	Black-eyed Susan	*Rudbeckia fulgida*
	Big blue stem	*Andropogon gerardii*
	Indian grass	*Sorghastrum nutans*
	Side oats grama	*Bouteloua curtipendula*
Crownvetch	Roundheaded bushclover	*Lespedeza capitata*
	Patridge pea	*Chamaecrista fasciculate*
	Big blue stem	*Andropogon gerardii*
	Little blue stem	*Schizachyrium scoparium*
	Indian grass	*Sorghastrum nutans*
	Switchgrass	*Panicum virgatum*
Tall fescue	Big blue stem	*Andropogon gerardii*
	Little blue stem	*Schizachyrium scoparium*
	Indian grass	*Sorghastrum nutans*
	Switchgrass	*Panicum virgatum*
	Broomsedge	*Andropogon virginicus*
	Deertongue	*Dichanthelium clandestinum*
	Side oats grama	*Bouteloua curtipendula*
	Canadian wildrye	*Elymus canadensis*
	Bottlebrush grass	*Elymus hystrix*
	Virginia wildrye	*Elymus virginicus*

Who Must Approve Use of Alternative Native Plants?

Users should work with the local Native Plant Society chapter (http://www.vnps.org/) or equivalent and the erosion and sediment control program authority to select appropriate native plant species. Note that the selection of plant species for vegetative stabilization must always be approved by the program authority as a part of the erosion and sediment control plan.